Delta Vision

Context Memorandum: Water Supply and Water Quality

This context memorandum provides critical information about water supply and water quality to support policy making. As they are developed, the context memos will create a common understanding and language about the critical factors in establishing a Delta Vision.

This is an iterative process and this document represents the beginning of a dialogue with you about how best to understand water supply and water quality and to inform recommendations by the Delta Vision Blue Ribbon Task Force. You have two weeks to submit comments that may be incorporated into the next iteration.

You may submit your comments in two ways: either online at dv_context@calwater.ca.gov or by mail. If you are using mail, please send your comments to: Delta Vision Context Memo: Water Supply and Water Quality, 650 Capitol Mall, 5th Floor, Sacramento, CA 95814.

Your attributed comment will be posted on the Delta Vision web site (http:www.deltavision.ca.gov). Please cite page and line number with specific comments; general comments may be keyed to sections.

Your participation in this iterative process is valuable and important and is greatly appreciated. Thank you for your comments.

Context Memorandum: Water Supply and Water Quality

Iteration 1: April 27, 2007

Section 1. General Policy

The purpose of this context memo is to provide a succinct situational report on the water supply and water quality issues in the Delta from which the Task Force can continue formulate policy actions. Much of the information contained in this memo is derived wholly or in part from information in the California Water Plan Update, 2005 (Water Plan).

California's water system is designed and managed to meet a number of demands in regions throughout the State. As the Water Plan notes:

> From a statewide perspective, California meets most of its agricultural, municipal, and industrial water management objectives in most years. Most of our demands are being met with the help of advances in water conservation and recycling, combined with infrastructure improvements including new storage and conveyance facilities. [*Water Plan*]

Placed in this context, the Delta faces an array of water supply and water quality challenges to continue to meet these objectives. The Task Force's actions resulting in a "durable vision for sustainable management of the Delta" [*Executive Order*] will be grounded in the water supply and water quality issues associated with the Delta.

The following fundamental policy questions frame the key issues embodied in this context memo:

- Is the statewide significance of water supplies exported to users outside of the Delta great enough to mandate a change in the current operations and methods of export?
- Are the long-term public health needs and economic considerations compatible with continuation of current in-Delta and export water supply operations?
- Are the long-term ecosystem needs of the Delta compatible with continuation of current in-Delta and export water supply operations and methods?
- How should in-Delta water use be addressed in light of the need to manage the Delta ecosystem and water supply exports?

Statewide Water Supply Context. In an average water year, California receives close to 200 million acre-feet of water in precipitation and surface water imports from the Colorado River, Oregon, and Mexico. As a representative average year, the total precipitation that fell on California in 2000 was estimated at 188 million acre-feet[1]. This quantity can vary significantly, though, with rainfall in 1998 estimated at 330 million acre-

[1] Statewide information is not available to differentiate what falls as snow versus rain.

feet, but only 140 million acre-feet in 2001. With the potential change climatic condition, the variance in precipitation, especially the portion falling as snow versus rain, may continue to dramatically vary.

In 2000, conditions were near average, with approximately 195 million acre-feet entering the State, composed of the aforementioned precipitation and close to 7 million acre-feet imported from outside California. To supplement these supplies and help meet the estimated 200 million acre-feet of "water leaving the State" and "evaporation and native vegetation evapotranspiration,"[2] the Water Plan includes changes in reservoir and groundwater storage – estimated at 1.3 and 4.4 million acre-feet, respectively. To reflect the inherent efficiency in the states natural and man-made delivery system, nearly 11 million acre-feet of the 195 million was "reused,"[3] with recycled water from urban wastewater systems contributing another 0.3 million acre-feet.

Of this total annual supply, about 50 to 60 percent is either used by native vegetation; evaporates to the atmosphere; provides water for agricultural crops and managed wetlands as "effective precipitation"; or flows to Oregon, Nevada, the Pacific Ocean, and salt sinks – like saline groundwater aquifers and the Salton Sea. The remaining 40 to 50 percent (about 80 million acre-feet), called the dedicated or developed supply, is (1) diverted for urban, agricultural and managed wetland uses, (2) dedicated for protecting and restoring the environment, or (3) stored in surface and groundwater reservoirs for use in future years. Urban, agricultural, and managed wetland diversions represent about half of the total dedicated supply – around 44 million acre-feet in 2000.

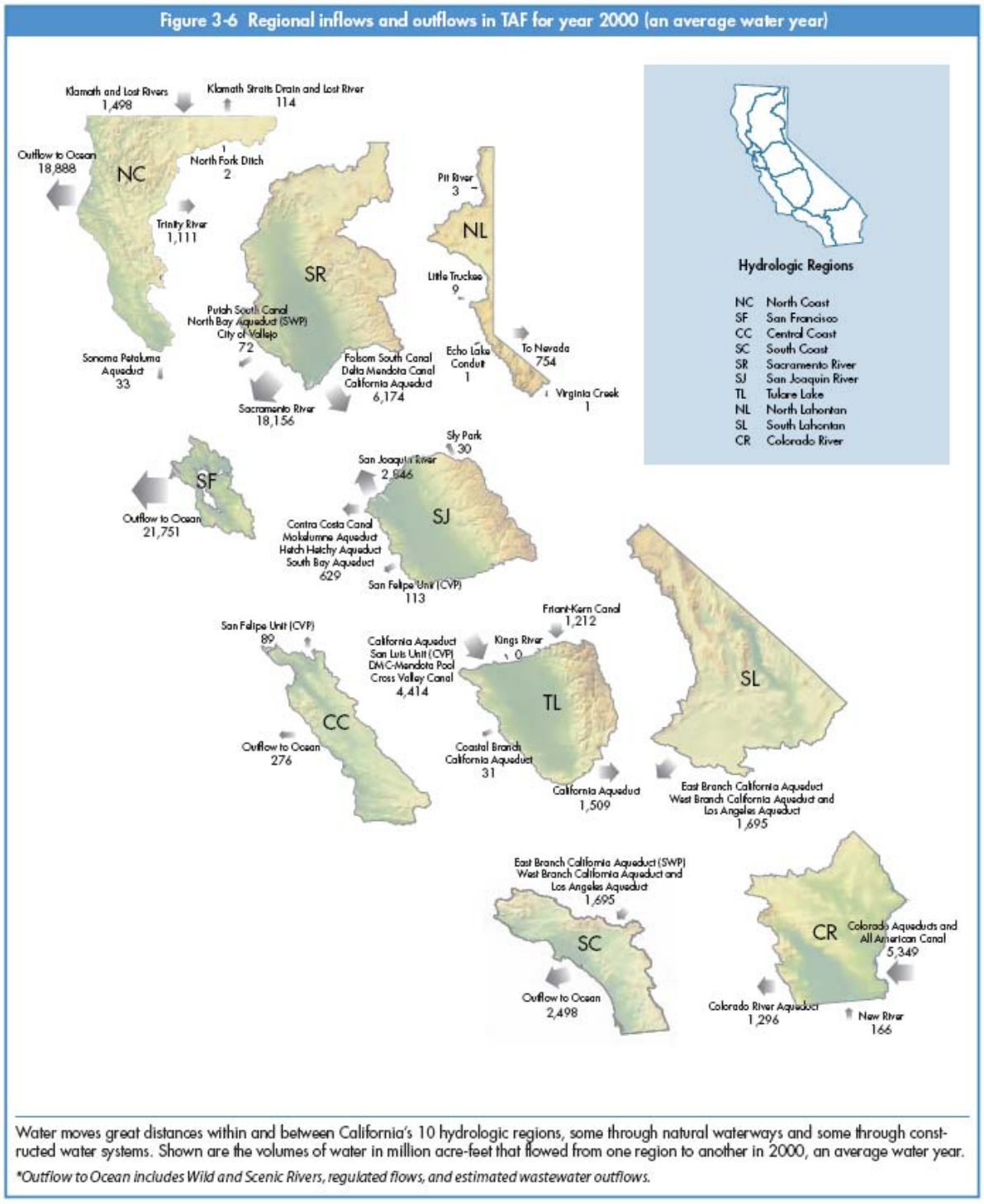
Figure 1 provides a graphical representation of the movement of water supplies among the designated hydrologic regions of the State.

[2] The Water Plan defines this demand as a combination of (1) consumptive use of applied water, outflow to other states, statutory outflow to salt sinks, and outflow to salt sinks, and (2) evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, natural and incidental runoff, and ag effective precipitation.

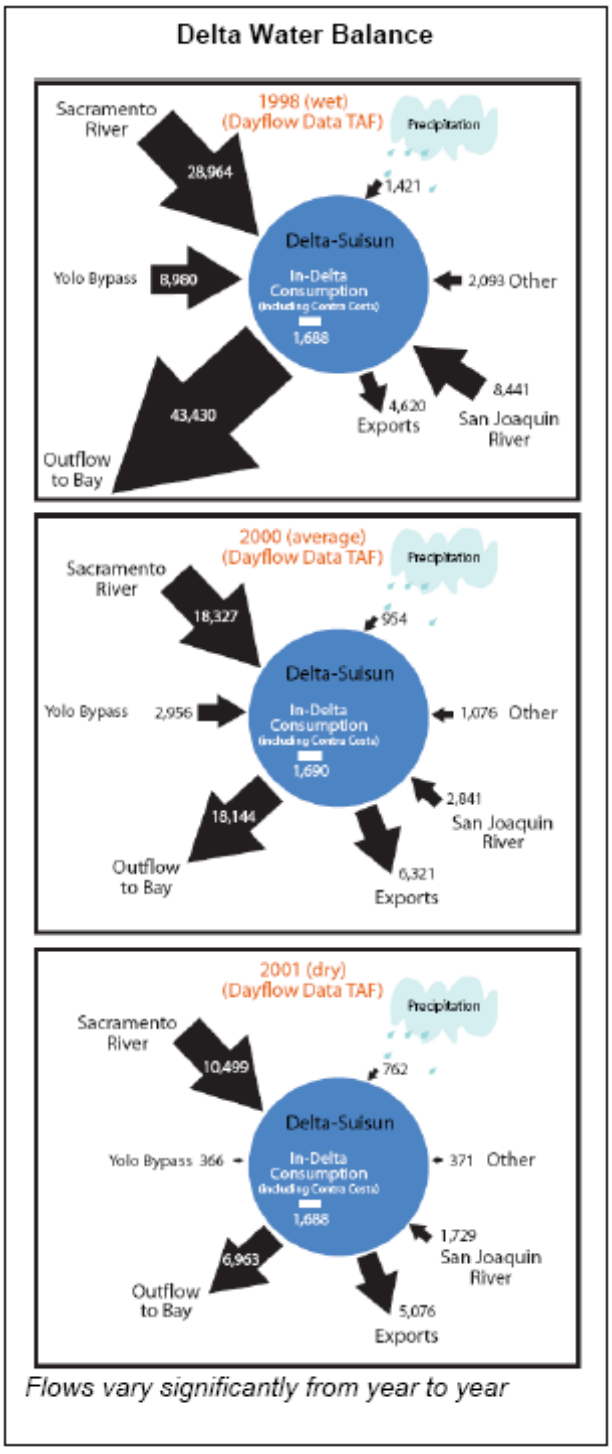
[3] The term "reuse" generally describes the re-diversion of water that was previously removed from surface or groundwater sources and applied for agricultural, urban or wetland consumption, but returned as surface runoff, deep percolation, or point discharge of treated wastewater back to the surface and groundwater supplies. The quantity of this return flow re-diverted for another use "downstream" in the sytem is considered the amount of "reuse."

Figure 1 – Regional inflows and outflows for an Average Water Year

(Graphic from California Water Plan Update 2005; Volume 1 page 3-10)



Delta-Centric Water Supply Context. As described in the March 2007 Status and Trends of Delta-Suisun Services report, flows that enter and leave the Delta-Suisun vary dramatically from year to year. Water supply includes not only the water used by farms, cities and businesses, but the flows in the rivers and channels that support the Delta ecosystem. Some of the water entering the Delta is diverted out of channels for use within the legally defined Delta, while a larger portion is exported for uses in areas outside of the legally defined Delta. The largest portion is outflow to the San Francisco Bay and Pacific Ocean. Figure 2 provides a representative view of these annual flows and how they vary under differing hydrologic conditions. This figure does not describe monthly flow characteristics, which can show more dramatic variation month-by-month.



Flows vary significantly from year to year

Attention to Delta Water Quality. Since water supplies derived from or conveyed through the Delta play a prominent role in the State's urban, agricultural and environmental water picture, the quality of the water is under constant analysis. Water quality in the Delta is governed by several State and federal laws, regulations and orders that collectively attempt to regulate upstream and in-Delta discharges as

well as effectively mandate how Delta water supplies are managed and used.

One key driver of Delta water quality is the State and federal drinking water standards. These standards are a delicate balance between protecting public health and the cost of treatment.

Some of the key contributors to Delta water quality concerns are:

- Salinity levels associated with daily tidal cycles
- Constituents from treated urban wastewater discharges from upstream and in-Delta sources
- Pollutants and organics from storm water runoff
- Temperature, chemicals, sediment and salinity[4] from upstream agricultural runoff and drainage
- Organics from agricultural drainage pumped from in-Delta lands

Further information regarding Delta water quality drivers, especially drinking water quality, is included later in this memo.

Section 2. Conceptual Models and Related Science and Engineering

To facilitate Task Force discussions, the following conceptual model is proposed: Separate water users currently reliant on the Delta into the following two groups:

- Users reliant on Water Rights derived from the Delta
- Users reliant on the Delta for Conveyance of other Water Rights

Though this grouping is somewhat of a gross generalization, it can be helpful to further detail (1) who are the users, (2) how much water they use, and (3) what are their primary drivers.

To help put this grouping into perspective, consider that of the nearly 28 million acre-feet[5] diverted and consumed annually statewide by agricultural, urban and managed wetland uses, about 6% is for in-Delta uses, and approximately 23%[6] is for

[4] Salinity in agricultural drainage primarily comes from irrigation practices on the west side of the San Joaquin Valley.
[5] According to the Water Plan, consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is estimated by the Water Plan to be approximately 44 million acre-feet annually. The average applied water value includes the consumptive use, reuse, and outflows associated with diverting water for the stated purposes.
[6] Contra Costa Water District's water diversions are included in this value. The District does hold pre-1914 water rights, but the majority of their consumption is derived from water supplied under CVP contracts (or flexed with water rights associated with Los Vaqueros Reservoir storage).

uses reliant on supplies conveyed through the Delta for export and use outside of the legally defined Delta. The remaining 70% of the statewide consumption is derived from supplies either available upstream of the defined Delta (i.e. Sacramento or San Joaquin Valleys) or altogether part of other watersheds (i.e. Colorado River, Kern River, Owens Valley). The following discussion provides a synthesis of useful information relevant to each grouping.

Users reliant on Water Rights derived from the Delta. Currently, these users rely upon a suite of predominantly riparian and pre-1914 water rights to directly divert and put to use Delta water supplies [see the Institutional Governance Affecting Delta Water Management context memo for more details regarding California Water Rights].

Though the primary water user in the Delta is individual farming operations, formal institutions have been established to manage Delta water. For instance:

> In November 1965, the Department of Water Resources and the U.S. Bureau of Reclamation reached agreement with some Delta interests on the quality of agricultural water to be maintained by the State Water Project and the Central Valley Project at various locations in the Delta. There was, however, no legal entity to sign the related contracts. As a result, the California Legislature created the Delta Water Agency. This Agency was replaced with three separate agencies in 1973 – the North Delta Water Agency, the Central Delta Water Agency, and the South Delta Water Agency. [*Delta Overview, 2007*]

Contra Costa County Water Agency (CCWD), East Contra Costa Irrigation District, and Byron-Bethany Irrigation District are the remaining local water-supply organizations. They are located in the southwest area of the Delta. CCWD is included in the conveyance grouping, however, because of their extensive CVP contracts.

Current and Projected Water Use. According to the Water Plan, the Delta consumes approximately 1.7 million acre-feet annually of the 28 million acre-feet consumed statewide[7]. Delta agriculture is the prominent water user in this group, consuming about 1.3 million acre-feet to irrigate about 475,700 acres of crops in 2000. This use is followed by the consumptive use for channel evaporation as well as the evapotranspiration for wetlands and riparian uses.

Urban uses, including industrial uses for the power plants at Pittsburgh and Antioch, represent the smallest portion of use within the Delta. Urban areas in the legally defined

[7] Table 12-2 in Volume 3 of the Water Plan indicates consistent consumptive use regardless of a wet, average or dry year. However, the value presented is derived from older information that is being re-evaluated as part of additional Water Plan activities.

Delta are shown in Figure 3. Though a small minority of urban communities draw water directly from the Delta, most of these communities rely on groundwater combined with rights and contracts pulling from upstream water sources. One exception is the City of Antioch, which diverts a combination of its own rights and purchases raw water diverted by Contra Costa Water District under its water rights.

Projected Use. Already present and expected to continue into the near and long-term future, pressures from urbanization within the legally defined Delta are being flagged as adding to demands for this group of Delta water supplies[8]. According to the Water Plan, the Delta population in 2000 was approximately 462,000. Urbanization in areas around Tracy, Stockton, Lathrop, Brentwood, Antioch and West Sacramento will increase this population.

Many of these communities do not intend to rely upon Delta water supplies to meet the demands of growth. For instance, Stockton has received approvals under California Water Code §1485 to re-divert discharged, treated wastewater. The cities of Tracy and Lathrop have entered into long-term contracts with the South San Joaquin Irrigation District for delivery of water under SSJID's water rights. The extent of indirect impacts to the Delta from potential increases in upstream diversions for these needs is not discussed here.

Agricultural use in the "primary zone" of the Delta will likely continue to decline slightly, as indicated in the Status and Trends of the Delta Suisun Services report[9].

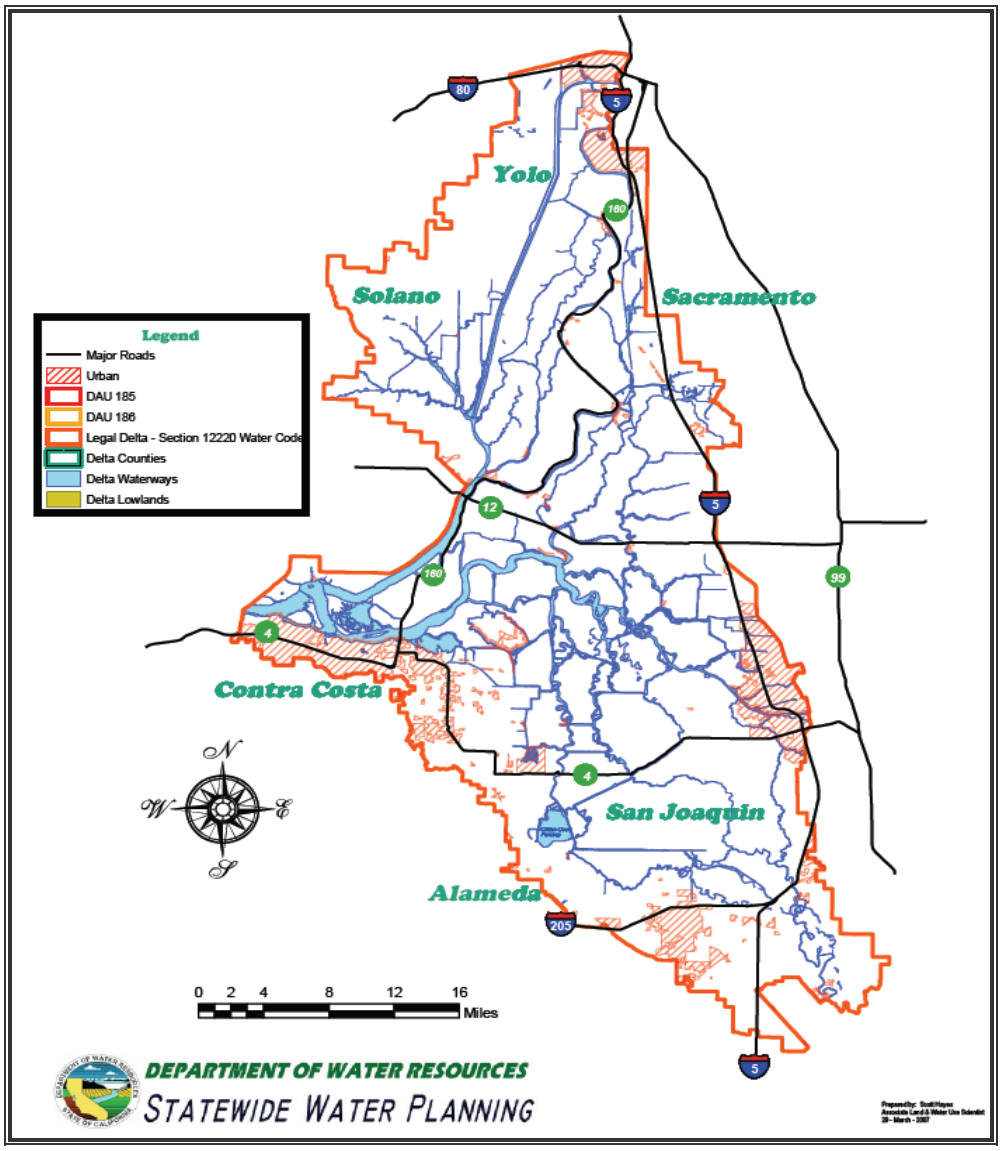
Primary Drivers. The users in the Delta water rights group have many drivers that implicate their strategic positions, management decisions, and financial investments. Since agriculture is by far the greatest water user in this group, the primary drivers are focused on agricultural production and preservation. Briefly, these include:

- Agricultural commodity prices and other economic elements that affect decisions of what to grow
- Water quality for irrigated crops
- Cost of levee maintenance and/or land reclamation after a catastrophic event
- Low cost and reliable water supply

[8] Most of the planned urban growth is anticipated to occur within the Delta's "secondary zone," which is defined by the Delta Protection Commission as "all the Delta land and water area within the boundaries of the legal Delta not included within the Primary Zone, subject to the land use authority of local government, and that includes the land and water areas as shown on the map titled "Delta Protection Zones" on file with the California State Lands Commission."

[9] The Status and Trends report indicated a decline of approximately 6% in agricultural land use between 1990 and 2004.

Figure 3 – Urban Areas within the defined Delta



Users reliant on the Delta for Conveyance of other Water Rights. Currently, these users rely upon the Delta's natural (and controlled) channels as a conduit to move water rights from one location to another. The water being diverted for export to a wide array of locations and uses is generally under the control of water rights permitted to the user by the State Water Resources Control Board (SWRCB) [see the Institutional Governance Affecting Delta Water Management context memo for more details regarding California Water Rights].

The most prominent of these users, having the greatest impact on the management of water in the Delta, are the State Water Project (SWP), the Central Valley Project (CVP) and Contra Costa Water District.

SWP Water Users. During the 1960s, as the (SWP) was being constructed, long-term contracts were signed with public water agencies, known as the State Water Project contractors (see Attachment A for listing of contractors and annual contract entitlements). They receive annual allocations of water derived from upstream reservoirs in the Delta watershed under the terms of their contracts. These contracts will expire in 2035. In return for the water supply, the contractors repay the principal and interest on both the general obligation bonds that initially funded the Project's construction and the revenue bonds that paid for additional facilities. The contractors also pay all costs, including labor and power, to maintain and operate the Project's facilities. Lastly, contractors fund all recreational facilities at many SWP lakes and reservoirs, and they contribute to costs to mitigate for any environmental impacts the Project's operations may have on fishery and wildlife.

Current and Projected SWP Water Use. As shown in the graphic and table of Attachment A, over 60% of the contracted entitlement is directed to urban uses in Southern California (approx. 2.6 million acre-feet of 4.1 million acre-feet of contract entitlements). Of this, the vast majority is contracted to the Metropolitan Water District of Southern California (MWD). However, because of many factors, the SWP deliveries to MWD have recently been 70% to 90% of their entitlement (with the exception of 2001, when supplies were at 40%)[10].

A second major SWP contractor is the Kern County Water Agency, which accounts for approximately 20% of the contracted entitlement at one million acre-feet. The predominant use in KCWA is agricultural irrigation. Recent deliveries have ranged from 65% to 90% of their entitlement (with the exception of 2001, when supplies were at 40%).

Together, these two agencies represent 30-40% of all of the supplies exported from the Delta (approximately 6.5 million acre-feet exported in 2000, of which about 2.4 million acre-feet were allocated to MWD and KCWA).

Projected SWP Use. Figure 4 shows historic deliveries for SWP contracts. Predicting how these uses may change (increase or decrease) is speculative. However, three scenarios could be envisioned:

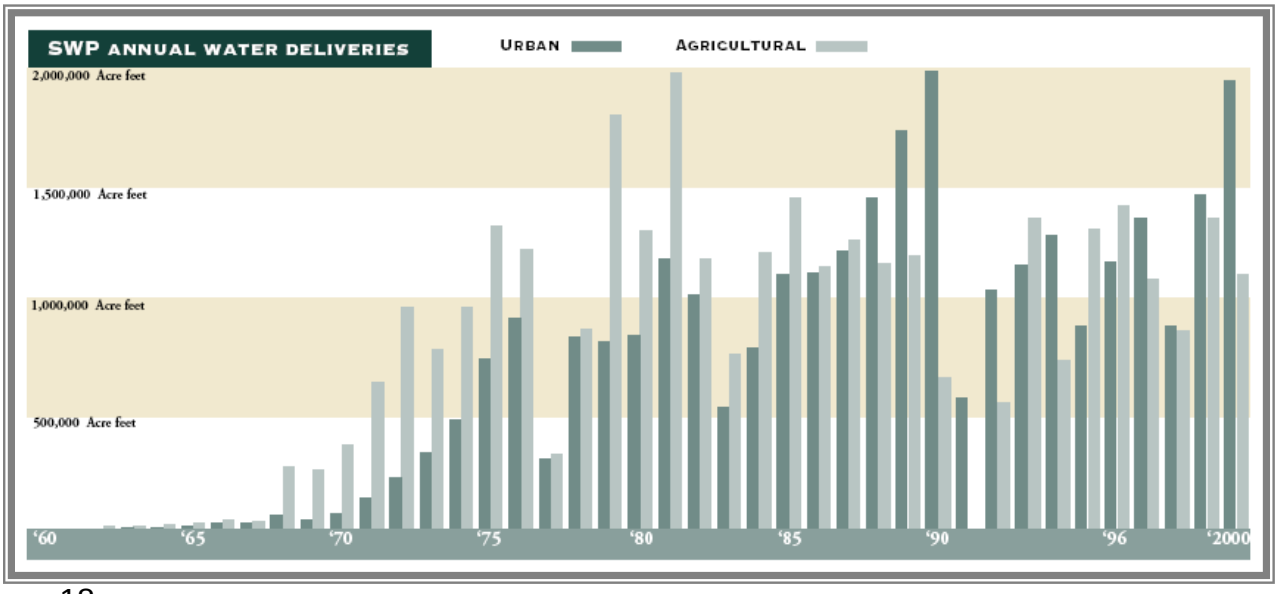
[10] These percentages are higher than the long-term (1972-2003) average reported by the Water Plan of 700,000 acre-feet. This is due to a combination of factors including dry years and limited requests by MWD.

- Scenario 1 – delivery rates seen between 2000 and 2005 will continue. Under this scenario, contractors such as MWD and KCWA will continue to receive about 2.4 million acre-feet annually. Deliveries will continue to average 70-90% of contract entitlements (except for dry years).
- Scenario 2 – delivery rates will increase to closer meet or fully match contract entitlements. Under this scenario, deliveries would likely be 90-100% of contract entitlements. This would likely represent a 0.5 to 1.0 million acre-foot increase in SWP exports.
- Scenario 3 – delivery rates decrease on average. Under this scenario, deliveries would likely be 50-70% of contract entitlements. This would likely represent a 0.5 to 1.0 million acre-foot reduction in SWP exports.

Regardless of the scenario, all of this water would need to be conveyed from its origin in the Delta watershed to the SWP contractors and therefore must be accounted for in policy decisions.

Figure 4 – Representation of Historic SWP Deliveries

(Graphic from DWR website: http://www.publicaffairs.water.ca.gov/swp/pdf/annualdeliveries.pdf)



A look at the phrases: "Water for two-thirds of California's residences passes through the Delta" and "The Delta is a source of drinking water for over 23 million Californians."

In simple terms, approximately 36 million people reside in California, with around 6 million in the SF Bay and 19 million in South Coast hydrologic regions (as defined by the Water Plan) – or about 70% of the population.

Water served to these two regions is derived from several locations, including the Delta. According to the Water Plan, about 40% of the SF Bay region's water is derived through exports from the Delta, with the South Coast at about 30%. In the case of the South Coast, the majority of the residences receive water from purveyors who purchase some or most of their water from MWD. However, even with MWD's array of infrastructure to manage varied sources of supplies and water quality, Delta water is not necessarily served to every residence in this region. In the SF Bay region, the interconnection of supply sources is more limited, thus resulting in a more direct correlation between the exporting water agency and their limited service areas.

At worst case, but very unlikely, the 40% and 30% values can be used to indicate Delta exports serve about one quarter of the State's population – or about 9 million Californians.

At best, they may serve a small fraction of water to the majority of the South Coast population, but still only about 40% of the SF Bay region. Thus, in the best case, Delta exports may serve about 60% of the State's population – or still about 21to 22 million Californians.

Reality may lie somewhere between these two values. In either case, the Delta plays a role in providing water supplies for an impressive number of Californians.

CVP Water Users. The Central Valley Project (CVP) plays a key role in California's powerful economy, providing water for 6 of the top 10 agricultural counties in California. According to Reclamation's web site, it has been estimated that the value of crops and related service industries has returned 100 times Congress' $3 billion investment in the CVP. In addition to providing water for farms, homes, and industry in California's Central Valley, the CVP provides significant water supplies to major urban centers in the San Francisco Bay Area, such as the Silicon Valley. In 2004, total industrial earnings in the Silicon Valley alone approximated $84 billion. The CVP is also the primary source of water for much of California's vital wetlands (outside of the Delta-Suisun).

Similar to its SWP counterpart, CVP contractors have an obligation to pay for the water supply and operations of the project, including the cost of ecosystem restoration activities mandated in 1992 by the Central Valley Project Improvement Act (CVPIA). However, overall CVP project repayment criteria can differ because of authorizing legislation, project purpose, and historical and projected use of the individual facility. Repayment for a project purpose may be reimbursable, nonreimbursable, or both. Costs allocated to water supply and power are predominately reimbursable, costs allocated to fish and wildlife may be reimbursable or nonreimbursable, depending on legislation, and costs allocated

to flood control, navigation, recreation and water quality improvement are traditionally nonreimbursable.

Attachment B, includes a list of the south-of-Delta CVP contractors, which represents an array of water service contractors, settlement/exchange contractors, water rights holders and wildlife refuges that rely upon the Delta as a conduit to deliver vital water supplies[11].

Current and Projected CVP Water Use. As shown in Attachment B, the water purveyors served with water supplies exported from the Delta have contracts for nearly 3.3 million acre-feet annually. However, as shown in Figure 4, historic deliveries have averaged around 2.5 million acre-feet (CVP exports in 2000 were 2.48 million acre-feet, *Water Plan*). Of the contracts, about 60% are agricultural water service contracts, while 25% are exchange/settlement contracts. This difference is important since the contractors with a water service contract face more frequent and greater reductions when supplies are not available. With the exception of dry-years, exchange/settlement contractors routinely receive 100% of their allocation.

Thus, in dry years or during critical months when pumping may be constrained because of regulatory requirements, exchange/settlement contractors will be the highest priority.

Projected CVP Use. Figure 5 shows historic deliveries for CVP contracts. Predicting how these uses may change (increase or decrease) is speculative. Many of the CVP contractors have recently undergone or are undergoing contract renegotiations, which may modify future conditions. Additionally, the federal government is negotiating with primary south-of-Delta CVP contractors for resolution of long-standing issues related to the management of agricultural drainage. These negotiations may include permanent land retirement, modified control of the operations of the CVP Delta export facilities, and other measures that will impact future operations and management of Delta water exports. However, in light of these unknowns, three scenarios could be envisioned:

- Scenario 1 – delivery rates seen between 2000 and 2006 will continue. Under this scenario, deliveries will continue to average 65-85% of contract entitlements for water service contracts, and normally 100% for exchange contractors.
- Scenario 2 – delivery rates will increase to closer meet or fully match contract entitlements. Under this scenario, deliveries would likely be 90-100% of contract

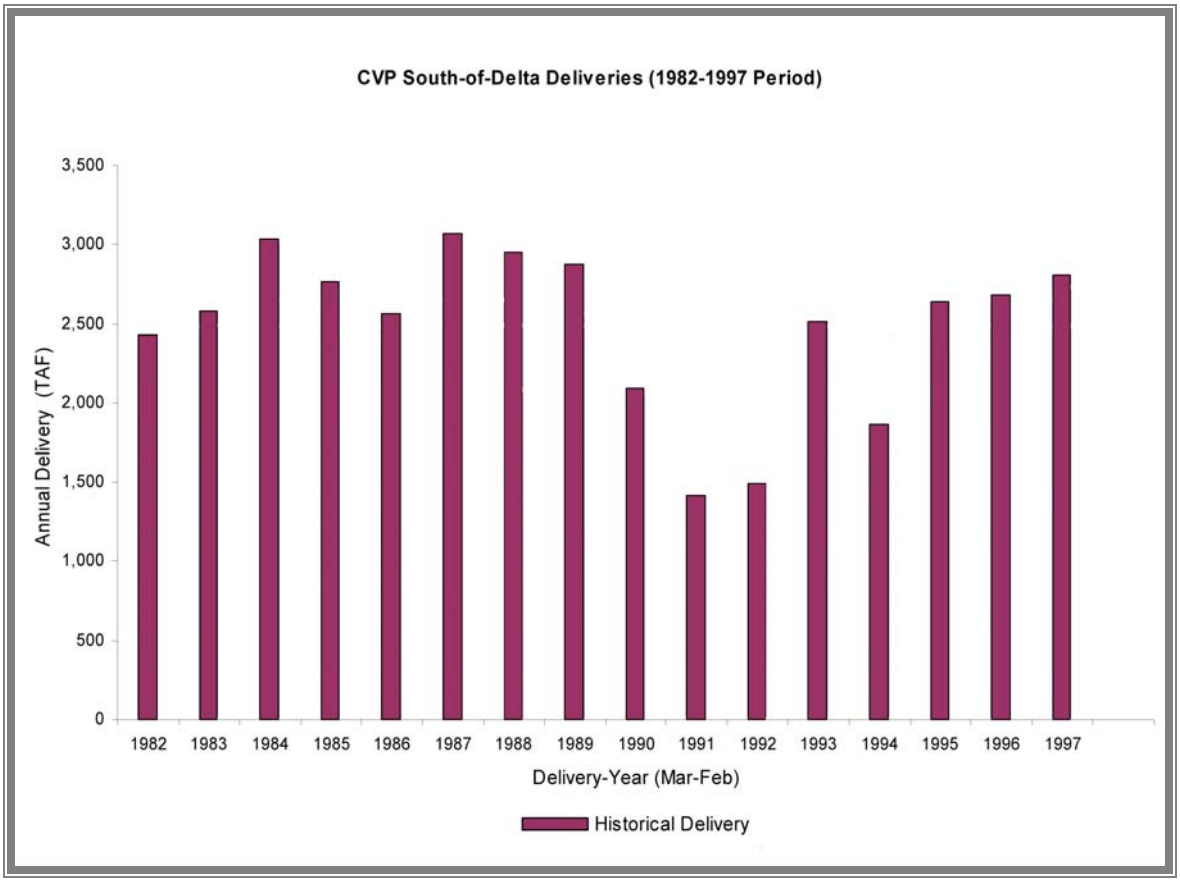
[11] CVP contractors north of the Delta are not included on this list, but play a vital role in the current and future planning and operations of the CVP.

entitlements for water service contracts. This would likely represent a 0.5 to 0.75 million acre-foot increase in CVP exports.

- Scenario 3 – delivery rates decrease on average. Under this scenario, deliveries would likely be 50% or less for water service contracts (with exchanges contracts still maintained at 100%). This would likely represent a 0.3 to 0.5 million acre-foot reduction in CVP exports.

Figure 5 – Representation of Historic CVP South-of-Delta Deliveries

(Derived from a table included in *CalSim II Simulation of Historical SWP-CVP Operations Technical Memorandum Report* - November 2003 http://science.calwater.ca.gov/pdf/CalSimII_Simulation.pdf)



Primary Drivers for SWP and CVP Users. CVP and SWP water exporters have many drivers that implicate their strategic positions, management decisions, and financial investments. Though the ultimate water customer (i.e. farmer, resident, industry) may have slightly different drivers than the water agencies that supply their water, the primary drivers outlined below are from the water agency perspective. Since the SWP and the CVP are by far the greatest water user in this group, the primary drivers are focused on their concerns. Briefly, these include:

- Agricultural water quality, especially concentrations of salinity that can impact crop performance, require greater water to leach from the root zone, and further complicate drainage issues.
- Farm economics, including the cost and reliability of water as it relates to crop choices. Current crop trends see permanent crops (i.e. nut trees) replacing annual crops. Permanent crops require greater supply reliability, since it now becomes impractical to leave the land "fallow" when water supplies are lacking.
- Drinking water quality that translates into treatment costs and health risks.
- Urban economics, including the cost and reliability of water from alternative sources as it related to minimizing the cost of water management.

Drinking Water Quality. Meeting drinking water quality standards requires significant investments in treatment and a prospective planning approach to ensure future requirements can be met in a timely fashion once regulations are promulgated. Urban water purveyors are satisfying current regulatory requirements, and planning 20-30 years into the future to meet the challenges associated with minimizing public health risks consistent with the best science.

However, the ability to pay for the best treatment varies for each purveyor who receives Delta water supplies. Some urban purveyors have the financial capacity to be proactive and have advanced treatment that provide water to standards even better than mandated, or may seek source water solutions to improve the viability of current treatment facilities. Yet, there are other purveyors who may, because of economic or other reasons, be satisfied with just meeting standards. In some instances, this varying threshold is an issue of environmental justice (i.e. one community cannot afford to pay for the same treatment afforded to another community).

In addition to treatment, source water quality protection is a critical component of a comprehensive water quality management program. To this end, urban purveyors "downstream" of Central Valley watersheds have actively sought opportunities to minimize runoff of water containing constituents that directly impact treatment or result in the development of disinfection byproducts after treatment. Source water protection programs have varied from incentive-based efforts to regulatory efforts such as the Central Valley Drinking Water Policy[12].

[12] Source water is separately protected through federal and state laws including the Clean Water Act and the Porter-Cologne Water Quality Control Act. Both contribute various regulatory components to the control of point and nonpoint source runoff (see the *Institutional Governance Affecting Delta Water Management* context memo for more details).

Constituents of Concern. Salinity, organic carbon and nutrients have been the primary focus of the CALFED Drinking Water Quality Program. Below, each is briefly discussed. The importance of these constituents varies by location in the Delta because the concentrations of each constituent are highly variable by location.

Salinity**.** Salinity is a broad water quality category that includes certain constituents in water that when treated result in byproducts that are probable carcinogens. Additionally, salts can contribute to taste and odor problems, impact water management programs such as recycling, economic impacts on residential and industrial use due to corrosion of appliances and impair agricultural uses. Salinity is commonly measured as electrical conductivity, bromide and chloride.

Higher salinity levels have a negative impact on urban and agricultural uses. Also, salinity variability has a negative impact on urban water treatment facilities that are typically designed to manage for certain constituent concentrations.

Bromide. High concentrations of bromide and chloride respectively are a concern because they contribute to formation of trihalomethanes (THMs) and bromate. Bromate and three of four regulated THMs are probable carcinogens. The San Joaquin River contributes high levels of bromide to the Delta.

Electrical Conductivity. A common measure of salinity, EC represents the ability of water to carry electrical current, and EC increases as concentrations of dissolved ions increases. EC is a simple and accurate method for determining concentrations of Total Dissolved Solids (TDS) in water where an EC/TDS ratio is known and can be used to estimate concentrations of bromide and chloride

Organic Carbon. Primary concern with organic carbon compounds in source water due to the potential formation of THMs and haloacetic acids (HAAs) resulting from disinfection with chlorine.

Nutrients. Nutrients, primarily nitrogen and phosphorus are naturally present in the Delta and are critical for maintaining the primary growth of the Delta. Excess amounts of N and P can enhance algae growth which in turn can reduce dissolved oxygen. This can result in increased organic carbon and algae toxins, causing taste and odor problems.

Section 3. History, Institutions, Policies and Economics of Water Supply and Water Quality

Annually diverting nearly 8 million acre-feet of water from the Delta entails a multitude of management and operational decisions made by an array of individuals as well as federal and State institutions. As described in the *Institutional Governance Affecting Delta Water Management* context memo, these decisions are made within a tangled, often controversial setting of laws, regulations, and agreements.

SWP and CVP Operations. Primary State and federal institutions involved in making operations and management decisions for Delta water supplies include the Department of Water Resources' State Water Project Analysis Office (SWPAO) and the U.S. Bureau of Reclamation's Central Valley Operations Office (CVO). SWPAO administers policies and procedures to ensure that the State Water Project delivers water to the millions Californians depending on it for at least a portion of their water needs. CVO manages the CVP facilities to serve CVP contractors at farms, homes, and industry in California's Central Valley as well as the major urban centers in the San Francisco Bay Area; it is also the primary source of water for much of California's wetlands.

Table 1 provides a quick overview of the laws, directives and orders affecting CVP and SWP operations. The information in the table was obtained from Reclamation's June 2004 CVP-OCAP document. A few of the key agreements used to manage water exports from the Delta are discussed below, including the Coordinated Operating Agreement (COA) and the Environmental Water Account (EWA).

Coordinated Operating Agreement. Dating back to 1960, the Coordinated Operating Agreement (COA) was a settlement between Reclamation and the State regarding protests to the SWP water rights applications. Since the CVP and SWP both use the Sacramento River and the Delta as a conveyance facility, the COA ensures that each project obtains its share of water and performs its commitment to protect beneficial uses in the Delta. Specifically, the CVP and SWP coordinate their reservoir releases and Delta exports to ensure each receives a benefit from the shared supply and each has a shared responsibility for meeting water quality standards in the Delta.

Environmental Water Account. The Environmental Water Account (EWA) consists of two primary elements: (1) implementing fish actions that protect species of concern in the Delta; and (2) acquiring and managing assets to compensate for the supply effects of those actions. Actions that protect fish species include pumping reductions at the SWP and CVP export facilities. Project pumping varies by season and hydrologic year and can affect fish at times when fish are near the pumps or moving through the Delta.

Reducing pumping can reduce water supply reliability for the SWP and CVP service areas, causing conflicts between fishery and water supply interests. A key feature of the EWA is use of water assets to replace supplies that are lost during pump reductions. The EWA assets can also provide other benefits such as augmenting instream flows and Delta outflows.

The EWA was initially identified as a 4-year cooperative effort intended to operate from 2001 through 2004 but was extended through 2007 by agreement among the EWA agencies. Efforts to further extend the EWA through 2010 are currently underway. It is uncertain, however, whether the EWA will exist after 2010.

Table 1 – Laws, Directives and Orders Affecting CVP and SWP Operations

(Table entries are excerpts from Table 1-1 of the June 2004 CVP-OCAP available at: http://www.usbr.gov/mp/cvo/ocapBA.html)

Coordinated Operating Agreement	1986	Agreement between the State and feds to determine the respective water supplies of the CVP and SWP while allowing for a negotiated sharing of Delta excess outflows and the satisfaction of in-basin obligations between the projects
SWRCB Orders 90-5, 91-1	1990 1991	Modified Reclamation water rights to incorporate temperature control objectives in the Upper Sacramento River
NMFS BO for Winter-run Chinook Salmon	1992 1993 1995	Established operation to protect winter-run and provided for "incidental taking"
CVPIA	1992	Mandated changes to the CVP particularly for the protection, restoration and enhancement of fish and wildlife
FWS BO for Delta Smelt and Sacramento Splittail	1993 1994 1995	Established operational criteria to protect Delta Smelt
Bay-Delta Plan Accord and SWRCB Order WR 95-06	1994 1995	Agreement and associated SWRCB order to provide for the operations of the CVP and SWP to protect Bay-Delta water quality. Also provided for development of a new Bay-Delta operating agreement (being pursued through CALFED)
Monterey Agreement	1995	Agreement between DWR and SWP contractors to manage contractor operations
SWRCB Revised Water Right Decision 1641	2000	Revised order to provide for operations of the CVP and SWP to protect Delta water quality
CALFED ROD	2000	Presented a long-term plan and strategy designed to fix the Bay-Delta
CVPIA ROD	2001	Implemented provisions of CVPIA including allocating 800,000 acre-feet of CVP yield for environmental purposes
NMFS BO for Spring-run Chinook Salmon and Steelhead	2001 2002 2004	Established criteria for operations to protect spring-run Chinook salmon and steelhead

SWP 4-Pumps Agreement. This 1986 agreement between the Department of Water Resources and the Department of Fish and Game provides for offsetting adverse fishery impacts caused by the diversion of water at the Harvey O. Banks Delta Pumping Plant, a key part of the State Water Project located at the head of the California Aqueduct. Direct losses of Chinook salmon, steelhead, and striped bass are offset or mitigated through the funding and implementation of fish mitigation projects. DWR and DFG work closely with the Fish Advisory Committee to implement the agreement and projects funded under the agreement. The Fish Advisory Committee is made up of representatives of the State Water Contractors, sport and commercial fishing groups, and environmental groups. (http://www.des.water.ca.gov/mitigation_restoration_branch/fourpumps/)

South Delta Improvements Program. Since 1990, DWR has installed temporary barriers in the south delta between April and November to minimize the migration of salmon into the south Delta via Old River and to control water levels and maintain water quality in the south Delta for agricultural diversions. The need for these barriers was driven in large part by the export pumping in the south Delta, which has impacted flow conditions, often to the detriment of the environment and in-Delta agricultural water users. Currently, pumping capacity at Banks Pumping Plant is 6,680cfs. This capacity presents operational constraints when the demand for water by SWP and CVP contractors south of the delta is greater than the amount of water that can safely be pumped from the Delta.

The South Delta Improvements Program (SDIP) purpose is to: (1) reduce migration of Chinook salmon into south Delta through Old River, (2) maintain adequate water levels and water quality for agricultural diversions in the south Delta, and (3) increase pumping capacity to serve SWP and CVP contractors south of the Delta. DWR and USBR are evaluating SDIP in two stages – Stage 1 (physical/structural component) and Stage 2 (operational component). Stage 1 includes analysis and issuance of a decision concerning the nature of permanent operable gates in the south delta, channel dredging, and extending agricultural diversions to deeper water. Stage 2 will entail issuance of a decision on the proposed operational component, including expanding permitted pumping capacity at Banks Pumping Plant to 8,500 cfs. In December 2006, SDIP issued a draft EIR/EIS for Stage 1 actions and efforts are currently underway to implement the improvements in 2008. Stage 2 is on hold.

Flooding and Droughts – the Impact of Hydrologic Variability on Delta Water Management. Hydrologic variability – resulting in high-water events or water supply shortages – add to the complexity of managing water supplies in the Delta. Predictions of future climate change may only increase this variability. In short, water operations can be affected in the following manner:

- Flooding. With the exception of events that cause areas normally kept dry to become inundated with water, high flows from heavy runoff generally do not have a significant affect on Delta water operations. Such events provide opportunities to "flush" salts out of the Delta and to make water available for export with minimal impact to ecosystem. High runoff events, however, create difficult situations for reservoir operators tasked with managing the balance of flood safety and water storage at reservoirs upstream of the Delta. When high flows or other events cause a breach in the system of levees protecting fertile Delta lands (i.e. a flood), Delta water operations can suddenly be severely impacted. As evident with the flooding of Jones Tract in the midst of summer 2004, both in-Delta and export water diversions were temporarily curtailed as salt water flowed back into the Delta. Many experts have stated that the Delta is at significant risk for additional levee failures, resulting in potentially lengthy delays in exporting water for CVP and SWP contractors. Furthermore, concepts have been proposed to permanently flood select Delta islands to improve the Delta ecosystem. The impact of permanent flooding to export water operations is a key concern raised by SWP and CVP contractors in opposition to these proposals.

- Droughts. During drought conditions, especially when water supplies in upstream reservoirs are depleted, the need to control in-Delta water quality and protect Delta fish and wildlife (per agreements and statues) often takes priority over and raises additional conflicts with export pumping. SWRCB's D-1641 illustrates this conflict with the inclusion of an import/export ratio intended to protect fish in the Delta from the effects of the export pumps relative to the amount of water coming into the Delta. In summer months, this ratio can require two units of water to flow out Carquinez Straits for every one unit exported from the CVP/SWP facilities. The unpredictability of drought conditions is also apparent in the methods used by CVP and SWP operators when proposing initial contract allocations for any given water year. Allocations are based on probability curves and other scientific tools, all designed to maximize the probability that any allocation made early in January and February will be met, even if expected precipitation is not realized.

Economics of Pumping Water. In addition to the complex array of laws, directives and orders, and hydrologic variability, operations of the CVP and SWP need to incorporate the economics of pumping water. Pumping millions of acre-feet annually results in a large demand for energy, especially for water that is pumped over the Tehachapi's to serve SWP contractors in Southern California. The cost of pumping is passed on to the water purveyors, who in turn pass the cost on to consumers in their water bills. As energy prices vary, attempting to maintain consistent, or at least

predictable, energy costs becomes more daunting. As an illustration of the impact water pumping can have, consider this excerpt from the California Energy Commission[13]:

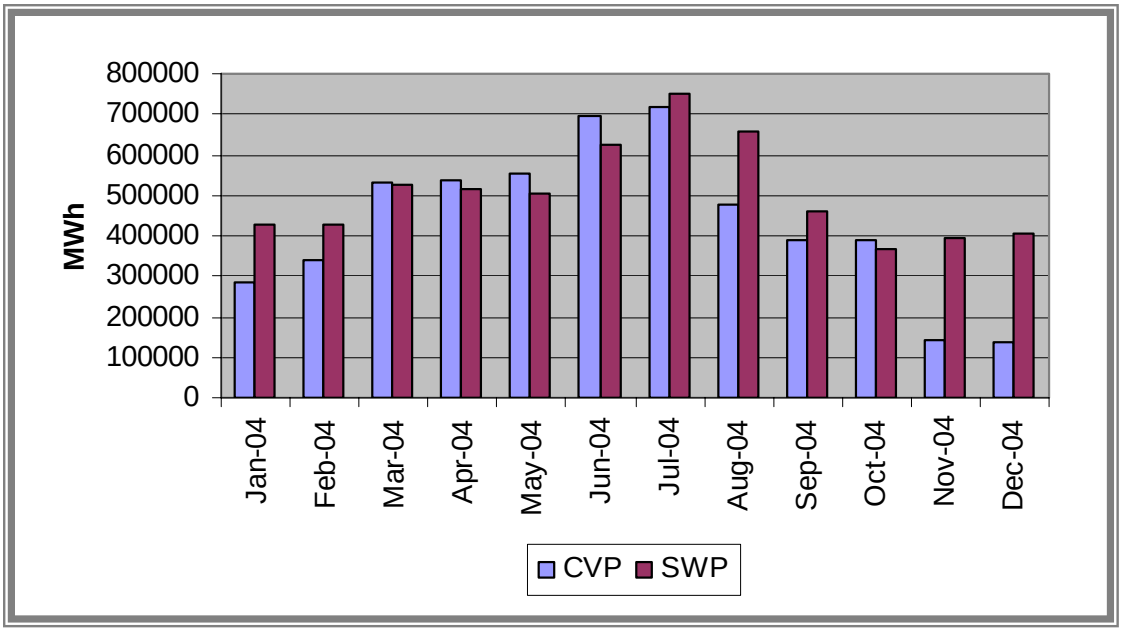
> The State and federal projects require substantial pumping to transport water from the Sacramento Valley to the Central Valley, the San Francisco Bay Area, and Southern California. The lift of SWP water to the top of the Tehachapi's for delivery to Southern California is the largest of these pumping efforts and requires over 2,200 kWh per acre-foot of water pumped. Reservoirs also generate electrical energy, and water projects are most often net producers of electrical energy. The net energy demands of surface water suppliers vary from project to project. For the SWP, energy demand also varies from customer to customer. For example, SWP water delivered to Bakersfield in the Kern County Agency requires a net energy input of 366 kWh/acre-foot; for water delivered to Los Angeles (at Castaic Lake Reservoir), a net of 1,666 kWh/acre-foot; and for water delivered to the San Bernardino Valley Municipal Water District, a net of 3,824 kWh/acre-foot.

As noted in the CEC's excerpt, the SWP and CVP projects also generate significant energy resources, much of which is used to meet the energy demands of the projects. Figure 6 provides a representation of hydropower production in 2006 generated by the CVP and SWP.

[13] Excerpt was taken from the following web site: http://energy.ca.gov/pier/iaw/industry/water.html, last updated in August of 2004.

Figure 6 – CVP and SWP Power Generation for 2004

(Derived from (1) CVP data for 2004 for Shasta, Keswick, Trinity, JF Carr, Spring Creek, Folsom, Nimbus, New Melones, Stampede, O'Neill, and San Luis, and (2) SWP data for 2004 for Hyatt-Thermalito, Gianelli, Alamo, Mojave Siphon, Devil Canyon, Reid Gardner Unit 4, and Warne)

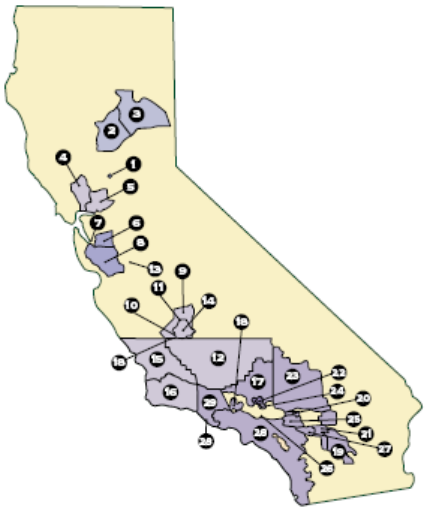


Electrical generation is produced as a direct result of releases of water through power facilities at CVP and SWP storage reservoirs. The ability to generate power however is complicated by demands placed on these same reservoirs to release cold water under certain conditions to facilitate fishery survival, as well as the need to meet downstream flow requirements and flood control releases that may not be optimally timed with power production. With the potential for more varied storage conditions under projected climatic changes, the opportunity, and overall production of hydropower will be further complicated. A discussion of beneficial or adverse impacts to power production associated with climate change is not included in this memo.

Section 4. References

To be developed

1 **Attachment A – SWP Water Users and Maximum Entitlements**



Water Contractors	Contracting Agency	Maximum Annual Entitlement (acre-feet)
	Upper Feather River	
	1. City of Yuba	9,600
	2. County of Butte	3,500
	3. Plumas County Flood Control & Water Conservation District	1,750
	Subtotal	**14,850**
	North Bay Area	
	4. Napa County Flood Control & Water Conservation District	21,850
	5. Solano County Water Agency	47,206
	Subtotal	**69,056**
	South Bay Area	
	6. Alameda County Flood Control & Water Conservation District, Zone 7	80,619
	7. Alameda County Water District	42,000
	8. Santa Clara Valley Water District	100,000
	Subtotal	**222,619**
	San Joaquin Valley	
	9. County of Kings	9,000
	10. Dudley Ridge Water District	57,343
	11. Empire West Side Irrigation District	3,000
	12. Kern County Water Agency	998,730
	13. Oak Flat Water District	5,700
	14. Tulare Lake Basin Water Storage District	106,127
	Subtotal	**1,179,900**
	Central Coast	
	15. San Luis Obispo County Flood Control & Water Conservation District	25,000
	16. Santa Barbara County Flood Control & Water Conservation District	45,486
	Subtotal	**70,486**
	Southern California	
	17. Antelope Valley-East Kern Water Agency	138,400
	18. Castaic Lake Water Agency*	82,500
	19. Coachella Valley Water District	23,100
	20. Crestline-Lake Arrowhead Water Agency	5,800
	21. Desert Water Agency	38,100
	22. Littlerock Creek Irrigation District	2,300
	23. Mojave Water Agency	75,800
	24. Palmdale Water District	17,300
	25. San Bernadino Valley Municipal Water District	102,600
	26. San Gabriel Valley Municipal Water District	28,800
	27. San Gorgonio Pass Water Agency	6,000
	28. The Metropolitan Water District of Southern California	2,011,500
	29. Ventura Country Flood Control District	20,000
	Subtotal	**2,559,200**
	Total State Water Project	**4,116,111**

**Note: Castaic Lake Water Agency acquired Devil's Den W.D. entitlement in 1992.*

Attachment B – Modeled CVP South-of-Delta Delivery Assumptions

CVP South-of-the-Delta as used for CACMP Future No Action Assumptions

CVP CONTRACTOR	CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non-CVP (TAF/yr)	Level 2 Refuges (TAF/yr)
	AG	M&I			
Byron-Bethany ID	20.6				
		20.0			
Banta Carbona ID	20.0				
Del Puerto WD	12.1				
Davis WD	5.4				
Foothill WD	10.8				
Hospital WD	34.1				
Kern Canon WD	7.7				
Mustang WD	14.7				
Orestimba WD	15.9				
Quinto WD	8.6				
Romero WD	5.2				
Salado WD	9.1				
Sunflower WD	16.6				
West Stanislaus WD	50.0				
Patterson WD	16.5			6.0	
Westlands WD #1 (Centinella WD)	2.5				
Panoche WD	6.6				
San Luis WD	65.0				
Broadview WD	27.0				
Laguna WD	0.8				
Eagle Field WD	4.6				
Mercy Springs WD	2.8				
Westlands WD #2	4.2				
Oro Loma WD	4.6				
Westlands WD #1 (Widren WD)	3.0				
Central California ID			140.0		
Grasslands via CCID					78.0
Los Banos WMA					8.3
Kesterson NWR					10.4
Freitas - SJBAP					5.5
Salt Slough - SJBAP					6.9
China Island - SJBAP					7.2
Volta WMA					13.0
Grassland via Volta Wasteway					22.1
Westlands WD (incl. Barcellos)	50.0				
Fresno Slough WD	4.0			0.9	
James ID	35.3			9.7	
Coelho Family Trust	2.1			1.3	

CVP South-of-the-Delta as used for CACMP Future No Action Assumptions (cont.)

CVP CONTRACTOR	CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non-CVP (TAF/yr)	Level 2 Refuges (TAF/yr)
	AG	M&I			
Tranquillity ID	13.8			20.2	
Tranquillity PUD	0.1			0.1	
Reclamation District 1606	0.2			0.3	
Exchange Contractors					
Central California ID			392.4		
Columbia Canal Co.			59.0		
Firebaugh Canal Co.			85.0		
San Luis Canal Co.			163.6		
M.L. Dudley Company				2.3	
Grasslands WD					29.9
Los Banos WMA					9.2
San Luis NWR					19.8
Mendota WMA					27.6
West Bear Creek NWR					7.5
East Bear Creek NWR					0.0
San Benito County WD (Ag)	35.6				
Santa Clara Valley WD (Ag)	33.1				
Pajaro Valley WD	6.3				
San Benito County WD (M&I)		8.3			
Santa Clara Valley WD (M&I)		119.4			
San Luis WD	60.1				
CA, State Parks and Rec	2.3				
Affonso/Los Banos Gravel Co.	0.3				
Panoche WD	87.4				
Pacheco WD	10.1				
Westlands WD: CA Joint Reach 4	219.0				
Westlands WD: CA Joint Reach 5	570.0				
Westlands WD: CA Joint Reach 6	219.0				
Westlands WD: CA Joint Reach 7	142.0				
Avenal, City of		3.5		3.5	
Coalinga, City of		10.0			
Huron, City of		3.0			
Cross Valley Canal - CVP					
Fresno, County of	3.0				
Hills Valley ID-Amendatory	3.3				
Kern-Tulare WD	40.0				
Lower Tule River ID	31.1				
Pixley ID	31.1				
Rag Gulch WD	13.3				
Tri-Valley WD	1.1				
Tulare, County of	5.3				
Kern NWR					10.4
Pixley NWR					0.0
Total CVP South-of-Delta	1987.1	164.2	840.0	44.3	255.8
				Total	3291.4

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